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ON CERTAIN VESICLES FOUND IN THE INTEGUMENT OF ANTS.

BY ADELE M. FIELDE.

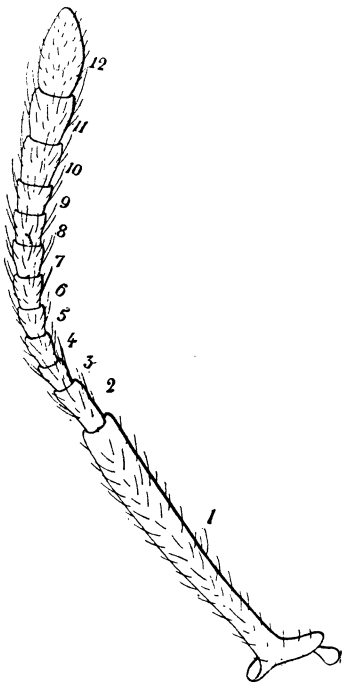
During the years 1900 to 1907, I demonstrated by experiments, duly set forth in print, that the antennæ of the ant are a pair of compound noses, certain segments having each a special function. The ants in my formicaries were subject to observation by day and by night, all the year round. The experiments were unhurried, very numerous, and with adequate material for every series. No ant that had not manifestly recovered normal health after the

required surgical operation was engaged in the service demanded by an experiment. (See *b*, page 425, and *j*, page 215.)¹

I found that the habitual activities of the ants are guided mainly by diverse odors, produced by the ants themselves, and discerned through the sub-noses of the olfactory organs, the funicles of the antennæ.

These odors are: (1) the odor of the domicile, the nest aura, made up of the commingled odors of the inhabitants, and discerned through the air by the distal segment of the antenna. The normal ant, warned by an alien aura, fears and avoids the habitation of any ant community other than her own, and she strives to flee or hide when forcibly introduced into the alarming atmosphere of an unknown

nest. But if the twelfth, the distal segment, is eliminated, the ant no longer distinguishes the domiciliary odor and stays fearlessly in



¹ See bibliography at conclusion of paper.

the abode of her enemies until her life pays the penalty of her unconscious temerity. This sub-nose appears to discern many odors, diffused in the air. (See *c*, page 539.)

(2) It is well known that ants of the same species abide in different colonies or communities so hostile to one another that an encounter between members of different colonies results in a battle, often prolonged until one or the other is exterminated. The undeveloped young of one colony are sometimes stolen and reared by the adults of another colony of the same species, but the adults of different colonies ordinarily maintain a mutual repugnance that is invincible, no matter how long an artificially enforced companionship may exist. The colony odor, depending on age, is discerned through the penultimate segment of the antenna. When this segment is eliminated, ants of different colonies of the same species live and work together in complete accord. They are then unaware of the objectionable odor of their comrades, as they no longer perceive what the normal ant discerns. The colony odor is discerned through contact of the antenna with the body of the ant subject to examination. This eleventh segment is, or contains, an organ of chemical sense which might be called olfactory or gustatory. (See *b*, page 449; *c*, page 531; *d*, page 609; *t*, page 1.)

(3) When an ant goes out from her dwelling, she lays down from her feet an odorous substance whereby she is guided on her return journey. She discerns her own scent through the antepenultimate segment of the antenna, and through the air. When this tenth segment is eliminated she is no longer able to retrace her steps and is completely bewildered. She is as incapable as is a dog in pursuit of a master who has waded. (See *c*, page 522.) But in her case the track remains, while power to pick up the scent has been destroyed in the pursuer.

(4) The next two segments of the funicle, the eighth and ninth counted from the proximal end of the antenna of *Stenamma fulvum piceum*, discern the odor of the queen and of the undeveloped young ordinarily her progeny. When these segments are eliminated, the worker ant, that in her normal condition evinced extreme devotion to the welfare of the inactive young and to the queen-mother, becomes wholly indifferent to all or any of those whom she has heretofore served. There are indications that the inactive young, as well as the queen, have a progressive odor, appreciable to the workers both by contact and in the air, and that the odor is a distinctive one, alluring to the workers. (See *c*, page 542; *k*, page 229.)

(5) The next two segments, the sixth and seventh from the proximal end of the antenna, discern the odor of ants of alien species, always regarded and treated as enemies unless acquaintance has been made in the earliest days of the individual ant's existence. Prolonged warfare and terrible slaughter often occur between ant colonies of different species. But if the sixth and seventh segments of the antennæ be eliminated, ants of different species or even of different sub-families will live together amicably and will regurgitate food to one another. I have had representatives of so many as five different genera living in close fellowship in the same nest. The specific odor is discerned by contact, the antenna being applied to some part of the body of the ant encountered. (See *h*, page 321; *k*, page 229.)

The two antennæ of the ant are identical in function, either one serving the purposes of both. Among the three or four thousand species of known ants the number of segments in the antennæ varies from four to thirteen. In my work of ascertaining the function of the antennal segments, I used mainly *Stenamma fulvum piceum*, a Myrmicine ant, having twelve segments in the antennæ. It is not improbable that further investigation, equally painstaking, would reveal olfactory functions in other segments than those tested by me. It is certain, however, that segments proximal to the sixth do not discern the odors appreciated by the seven at the distal end.

Since the ants have given evidence that they bear in their bodies several different odors, they must have glands producing unlike odors. The nest aura requires no separate apparatus, because its creation is effected by the combined odors of the inhabitants of the nest. The colony odor, inherited from the queen and changing with age of the ants, demands a means of production that might well be inquired for along the sides of the thorax where the ants so commonly apply a caressing antenna. The scent that is laid down on the track would probably issue from the feet or legs, while the odor of the queen would be produced in some gland that would be no more than rudimentary in the workers. The diverse specific odors are easily discernible by human nostrils; and even an ant may be temporarily deceived by an individual of the enemy's troop painted with the blood of a friend. There must be glands for producing this odor.

Many observers have described certain vesicles in the integument of ants, as well as of many other insects, since Hicks first studied them. (1857 to 1860.) Janet, whose work on the anatomy of the

ant has been long continued, highly skilled and very prolific, shows these organs as a pit communicating with the external air by means of a pore. They have been variously named. I suggest to myrmecologists the possibility that these vesicles found in groups or scattered over the body and limbs of the ant may be the producers of the odors borne by the insect, and I urge research among Forel's "inverted flasks," the "pits and pegs," the "plates and pores," and all papillæ on the ant.

Dr. N. E. McIndoo, of the Bureau of Entomology at Washington, D. C., has issued two papers, one in April, 1914, *The Olfactory Sense of the Honey Bee*, and one in November, 1914, *The Olfactory Sense of Insects*. I venture a few brief comments thereupon.

Dr. McIndoo quotes Dr. W. M. Wheeler's objection to my discovery that "the olfactory organs of an animal may exhibit 'regional differentiations.'" This objection, unsupported as it is by physiological tests applied to the ant, should influence no investigator. If there be error in the process of experimentation or flaw in the logic of the deduction, the critic should indicate the point of departure from a correct course. It is true that my statements are "unsupported by other observers," but lack of support by other observers is a misfortune that necessarily befalls the research worker who makes the earliest observation.

Dr. McIndoo's iterated statement that his bees were "abnormal," without definite indication of the cause or kind of abnormality, gives no assistance in the formation of a sound judgment concerning the changes due to mutilation. "Abnormality" of some sort is a natural consequent of mutilation. The question is whether a certain abnormal condition invariably ensues from a particular mutilation.

In those cases where Dr. McIndoo's surgical operations upon his bees were performed by the pulling apart or the burning off of segments, the lesions produced in the adjacent tissues must have been such as to seriously affect the functions of the parts subject to subsequent observation.

The odors of the essential oils used in his experiments must have been diffused through the air, and the reaction of the bees, normal or abnormal, may in many cases have been due to the effect of the odorous particles upon the trachea through the spiracles rather than to their appeal to the sense of smell.

Dr. McIndoo's experiments and observations appear to me to be confirmatory rather than contradictory of the view of most ento-

mologists that the antennæ are the organs of smell in insects. The evidence he sets forth is far from being convincing of the truth of his final asseveration that "the antennæ can no longer be regarded as the seat of the sense of smell in insects"; and equally remote from acceptance should be his conclusion that the organs he chooses to call "olfactory pores" "are the true olfactory apparatus in Hymenoptera."

LIST OF MISS FIELDER'S PUBLISHED PAPERS ON ANTS.

- (a) Portable Ant Nests. Biological Bulletin, Vol. II, No. 11, September, 1900.
- (b) A Study of an Ant. Proceedings of the Academy of Natural Sciences of Philadelphia, July, 1901; issued September 4, 1901.
- (c) Further Study of an Ant. Proceedings, October, 1901; issued November 22, 1901.
- (d) Notes on an Ant. Proceedings, September, 1902; issued December 4, 1902.
- (e) Supplementary Notes on an Ant. Proceedings, June, 1903; issued September 4, 1903.
- (f) Experiments with Ants induced to Swim. Proceedings, September, 1903; issued October 5, 1903.
- (g) A Cause of Feud between Ants of the same Species living in different Communities. Biological Bulletin, Vol. V, No. 6, November, 1903.
- (h) Artificial Mixed Nests of Ants. Biological Bulletin, Vol. V, No. 6, November, 1903.
- (i) Observations on Ants in their Relation to Temperature and Submergence. Biological Bulletin, Vol. VII, No. 3, August, 1904.
- (j) Portable Ant Nests. Biological Bulletin, Vol. VII, No. 4, September, 1904.
- (k) Power of Recognition among Ants. Biological Bulletin, Vol. VII, No. 5, October, 1904.
- (l) Reactions of Ants to material Vibrations. Proceedings, September, 1904; issued November 2, 1904.
- (m) Three Odd Incidents in Ant Life. Proceedings, September, 1904; issued November 2, 1904.
- (n) Tenacity of Life in Ants. Biological Bulletin, Vol. VII, No. 6, November, 1904.
- (o) The Sense of Smell in Ants. The Independent, August 17, 1905.
- (p) How an Ant went to Market and came Home again. Written October, 1905. In Boys and Girls' Magazine, Ithaca, New York, April, 1906.
- (q) Temperature as a Factor in the Development of Ants. Biological Bulletin, Vol. IX, No. 6, November, 1905.
- (r) Observations on the Progeny of Virgin Ants. Biological Bulletin, Vol. IX, No. 6, November, 1905.
- (s) The Communal Life of Ants. Nature-Study Review, Vol. I, No. 6, November, 1905.
- (t) The Progressive Odor of Ants. Biological Bulletin, Vol. X, No. 1, December, 1905.
- (u) Longevity of a Velvet Ant. Biological Bulletin, Vol. XI, No. 5, October, 1906.
- (v) Suggested Explanations of certain Phenomena in the Lives of Ants. Biological Bulletin, Vol. XIII, No. 3, August, 1907.
- (w) The Nose of an Ant. Spinning Wheel Magazine, Vol. I, No. 2, December, 1914.